Renewable and Sustainable Energy Reviews 15 (2011) 2850–2861

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Green progress and prospect in Malaysia

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ARTICLE INFO

Article history:
Received 14 October 2010
Accepted 1 March 2011

Keywords:
Green technology
Green building
Renewable energy
Energy efficiency

ABSTRACT

This paper aims to present Malaysia's green developments, focusing on the National Green Technology Policy and Green Building Index which have been introduced since 2009. Various green initiatives and their progresses to date will be discussed as well as the key implementing green agencies. The benefits of going green to the country and incentives being offered by the Malaysian Government are also presented. The prospect of a green future in Malaysia, spurred by the worldwide outlook towards sustainable development and environmental preservation is very bright. Pursuing green technology in economic and social developments not only helps sustain the non-renewable fuels, safeguards and minimises the environmental degradation due to carbon emissions, it also creates a strong green economy and industry, inline with the country's vision as well as the rest of the world economies.

Contents

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doi:10.1016/j.rser.2011.03.008

1. Introduction

It seems not long ago that the world community has finally realised that pursuing social development and economic progress come with a price, the long term degradation and possibly irreversible damage to the environment. Between 2009 and 2030, the global primary energy consumption is expected to rise by 1.6% annually [1]. The over-dependence on fossil fuels and over-exploitation of earth's natural resources have now become obstacles for sustainable development in many countries. Global energy related emissions of CO_2 are expected to rise from 20.9 Gt in 1990 to 28.8 Gt in 2007. It is then projected to reach 34.5 Gt in 2020 and 40.2 Gt in 2030, an average growth rate of 1.5% per year [2]. Countries like UK, US, Japan and Singapore have pushed forward many best practices for sustainable development and environmental management while pursuing economic and social development.

One of the many best practices is by going 'green'. This paper examines Malaysia's progress and prospect in going 'green'. Section two discusses important green policies such as utilisation of renewable energy (RE), adoption of energy efficiency (EE) and promotion of green technology (GT) for sustainable development and towards environmental protection. An important policy for going 'green' is the National Green Technology Policy (NGTP2009) launched in 2009 which marked an important point at spurring the country's green development. Section three introduces the key GT agencies in Malaysia. Section four introduces key initiatives precursor to NGTP2009 and thereafter picks up the progress of green development after the launch of NGTP2009. An important initiative called the Green Building Index (GBI) launched three months before NGTP2009 will be separately discussed in section five. Section six presents the benefits by going 'green' as well as tax incentives by implementing 'green' programmes. Malaysia's prospects of a 'green' future will be examined in section seven and lastly the conclusions in section eight.

2. Green policies

Malaysia's framework for energy development in terms of energy diversification and efficient utilisation as well as emphasis on sustainable environmental started when National Energy Policy 1979 (NEP79), National Depletion Policy 1980 (NDP80), Four Fuel Diversification Policy 1981 (4FDP81) and Fifth Fuel Policy 2000 (5FP2000) were formed. NEP79 was formulated with three objectives: (i) supply: to ensure the provision of adequate, secure and cost effective energy supplies through developing indigenous energy resources, both non-renewable and RE resources using the least cost options and diversification of supply sources both from within and outside the country, (ii) utilisation: to promote EE and discourage wasteful and non-productive patterns of energy consumption, and (iii) environment: to minimise the negative impacts of energy production, transportation, conversion, utilisation and consumption on the environment. Realising the depletion of fossil fuel reserves, NDP80 was formulated and aimed at safeguarding the depleting crude oil and natural gas reserves. To further provide assurance in formulating energy policies, backed by sufficient energy data and trends, the National Energy Balance (NEB) was initiated. NEB was formed to present basic supply and demand data for all fuels expressed in a common energy unit. NEB serves as a reference in formulating new policies for the energy sector. NEB utilises the Malaysia Energy Database and Information System (MEDIS) which is a comprehensive national database and information system to support integrated national energy planning and acts as an information centre for economic, demographic and other energy related data [3]. 4FDP81 was designed to avoid over-dependence on oil as main energy supply and aimed at placing increase emphasis on gas, hydro and coal in the existing energy mix. As a result, natural gas became the major fuel in electricity generation since the early 1980s. 55.9% of the fuel mix in the electricity generation for 2010 was from natural gas, followed by coal 36.5%, hydropower 5.6% and oil 1.8%. Over the years, the contribution of the different energy fuel mix was closely monitored to reduce over-dependence on any one fuel and at the same time ensuring further diversification in the fuel mix in the electricity generation. This can be seen from Fig. 1 as oil and gas contributions in the fuel mix in the electricity generation dropped while of coal increased from 2000 to 2010.

With escalating oil price and environmental degradation, the Government of Malaysia (GoM) introduced the 5FP2000 which made RE as the fifth fuel during the Eight Malaysia Plan (8MP) 2001–2005 with more concerns placed on sustainability and efficiency of energy developments. The GoM recognises that the conventional energy sources such as oil and natural gas are non-permanence and thus placing emphasis on non-conventional energy sources such as biomass, biogas, municipal waste, solar and mini-hydro for electricity generation. From thereon, the GoM has focused on EE in the industrial and commercial sectors as well as residential in the domestic sectors, utilisation of RE by promoting new RE resources such as biomass, biofuel, landfill gas, mini hydro and solar. Further reading on sustainable RE in Malaysia can be found in [4–6]. With Malaysia as the major exporter of palm oil in the world, the National Biofuel Policy (NBP2006) was implemented in 2006 to promote the usage of biofuel from palm oil as an alternative and environmentally friendly energy source for the transport sector. The use of biofuel reduces the use of fossil fuels and minimises the emission of green house gases (GHGs).

Malaysia's electricity demand is expected to reach 18,947 MW in 2020 and 23,092 MW in 2030 which is 35% increment from 14,007 MW in 2008 [1]. Currently, Malaysia's electricity capacity through RE stands at 50 MW and it is expected to reach about 2000 MW by 2020. To show the government's commitment to promote low carbon technology and ensure sustainable development while conserving natural environment and resources, NGTP2009 was launched in July 2009 [7] by the Prime Minister (PM) of Malaysia, Datuk Seri Najib Tun Abdul Razak, with objectives: (i) to minimise growth of energy consumption while enhancing economic development, (ii) to facilitate the growth of the GT industry and enhance its contribution to the national economy, (iii) to increase national capability and capacity for innovation in GT development and enhance Malaysia's competitiveness in GT in the global arena, (iv) to ensure sustainable development and conserve the environment for future generations, and (v) to enhance public education and awareness on GT and encourage its widespread use. EE and RE will further be promoted and supported under this policy. The NGTP2009's goals are aimed at progress and improvements made in major sectors such as energy, buildings, water and waste management, and transportation (in Table 1) as well as R&D, innovation and commercialisation through collaboration with local and multi-national companies. Table 2 shows NGTP2009's short, medium, and long term goals which span three Malaysian Plans.

3. Green agencies

The developments of GT are governed by different bodies in different areas of RE and EE. The overall GT implementation and policy makings lie within MEGTW, GTM and GTC.

3.1. Ministry of Energy, Green Technology and Water

Ministry of Energy, Green Technology and Water (MEGTW) [8] was established on April 2009 following Malaysia's new cabinet line-up and restructuring, replacing Ministry of Energy, Water and Communications established since 2004 after the government sees

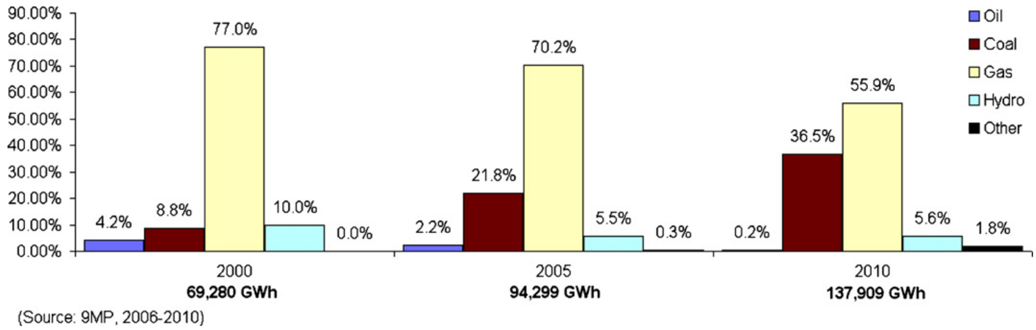


Fig. 1. Fuel mix in total electricity generation in Malaysia, 2000–2010.

Table 1
Progress and major improvements in the NGTP2009 by sectors.

Sector	Progress and major improvements
Energy	*Supply*: to apply GT in power generation and in the energy supply side management, including co-generation by the industrial and commercial sectors *Utilisation*: to apply GT in all energy utilisation sectors and in demand side management programmes
Buildings	To adopt GT in the construction, management, maintenance and demolition of buildings
Water and waste management	To adopt GT in the management and utilisation of water resources, waste water treatment, solid waste and sanitary landfill
Transportation	To incorporate GT in the transportation infrastructure and vehicles, in particular, biofuels and public road transport

a growing need and necessity of GT towards sustainable development. MEGTW's role is to administer and manage the nation's energy, GT and water functions as well as facilitates in developing GT policies and roadmaps.

3.2. GreenTech Malaysia

Malaysia Energy Centre (MEC) was established in 1997 for the development and coordination of energy research. MEC members include individuals and companies across the entire spectrum of Malaysian energy industry such as electricity power industry, oil and gas industry, research institutions, institutions of higher learning, service providers, suppliers and energy consumers. MEC's four major functions are in: (i) energy policy research, (ii) guardian and repository of the national energy database, (iii) promoter of national EE and RE programmes, and (iv) coordinator and lead manager in energy research and development, and demonstration projects. During the Malaysian Budget 2010 on October 2009, the PM initiated the rebranding of MEC. The rebranding has transformed MEC into the focal point for the development of GT in Malaysia. Malaysian Green Technology Corporation [9] or GreenTech Malaysia (GTM) is now the new MEC.

3.3. Green Technology Council

Green Technology Council (GTC) was set up in 2009 to accelerate the development of GT in Malaysia with the objectives: (i) to formulate strategies and policies as well as provide direction for the implementation of GT, (ii) to monitor the effectiveness of the implementation of the NGTP2009, (iii) to re-evaluate the achievements of national objectives pertaining to GT, and (iv) to lead initiatives in the area of GT in Malaysia. It is chaired by the PM with five working committees in industrial, research and innovation, human capital, promotion and public awareness, and transportation. GTC members include figures holding high portfolios such as the deputy PM, Minister of Energy, Green Technology and Water, Minister of Transport, Minister of Higher Education, Minister of International Trade and Industry, Minister of Science, Technology and Innovation, Minister of Natural Resources and Environment, Minister of Housing and Local Government, CEO of the National Green Technology Agency and other important stakeholders in private sectors.

Table 2
NGTP2009 goals.

Malaysian plan	Goals
Tenth (2011–2015)	Increase public awareness and commitment for the adoption and application of GT Widespread availability and recognition of GT in local market Increase foreign and domestic direct investments in GT Expansion of local research institutes and institutions of higher learning
Eleventh (2016–2020)	GT to be the preferred choice in procurement of products and services Increase production of local GT products Larger local market shares in GT Expansion of local small medium enterprises and small medium industries on GT into global market Increase research, development and innovation of GT by local universities and research institutions Expansion of GT applications to most economic sectors
Twelfth (2021–2025)	Inculcation of GT in Malaysian culture Widespread adoption of GT to reduce overall resource consumption while sustaining national economic growth Significant reduction in national energy consumption Improvement of Malaysia's ranking in environmental ratings Malaysia as a major producer of GT in the global market Expansion of international collaborations between local universities and research institutions with GT industries

Table 3
Energy development projects before NGTP2009.

Project	Descriptions and outcomes
MIEEIP (2001)	To improve EE in industrial sector which focuses on eight energy consuming industrial sub-sectors—food, wood, ceramic, cement, glass, rubber, pulp and paper, and iron and steel. Findings on 48 audited factories which consumed ~39 PJ annually (9% of total final energy consumed by manufacturing sector in 2004), found an energy saving between 1.6% and 35% of the annual energy consumption could be achieved. Implementing EE measures by the factories will reduce energy consumption by 5.6% and fuel demand will drop by 26.7% with potentially more than 1.5 mil tonnes per year of avoided CO_2 emissions
SREPP (2001)	To encourage private sectors to undertake small power generation projects (10 MW to the grid) using renewable resources: biomass, biogas, municipal waste, solar, mini-hydro, and wind energy with target of 600 MW (or 5%) of the country's electricity demand by 2005 but only 12 MW of combined capacity from a biogas and a biomass project was commissioned and connected the grid. As of July 2009, another 31.5 MW had been generated and connected to the grid, yet still far below the 2005 target
BioGen (2002)	To support RE efforts to curb the growth of GHG emissions from fossil fuel fired combustion processes by making use of unutilised biomass waste through power generating capacity using cogeneration technology. In 2006, two full scale demonstration projects were selected and by 2009, these projects delivered a combined 10.5 MW to the grid
MBIPV (2005)	To reduce long-term cost of BIPV technology, which will lead to sustainable and widespread BIPV technology applications that avoid GHG emissions from the country's electricity sector. Buildings build using BIPV will have all BIPV panels integrated into the building design which provide some electricity the buildings used. The building will consume low energy as it combines EE measure and RE generation system. The BIPV system is also connected to the national electricity grid, help to ease the power demand. MBIPV has succeeded in implementing showcase, demonstration, SURIA 1000 and SURIA for developers programmes

Abbreviations: MIEEIP: Malaysian Industrial Energy Efficiency Improvement Project; SREPP: Small Renewable Energy Power Programme; BioGen: Biomass Power Generation and Cogeneration in Palm Oil Industry Project; MBIPV: Malaysia Building Integrated Photovoltaic Technology Application Project.

3.4. Malaysia Green Building Confederation

Malaysia Green Building Confederation (MGBC) [10] was registered in April 2009 with a vision to be the leader in green building in Southeast Asia and to become the main promoter of green practice, and the main sustainability reference organisation within the growing construction market sector. It aims to involve policymakers, professionals, and the society at large, in the quest for transforming the building industry into one that respects environment by embracing green issues that lead building industry in embracing responsible measures that would help realised energy savings, water conservation, healthy indoor environment, better public connectivity, recycling of valuable resources and provision of greenery in developments. Key roles of MGBC include: (i) collaborate and support the government and industry to develop a sustainable built environment, (ii) facilitate exchange of knowledge in the field of sustainable built environment, (iii) reference centre for sustainable building resources, (iv) platform for networking on sustainability matters nationally and internationally, (v) promote and stimulate demand for sustainable buildings, and (vii) support, promote and provide input to the Malaysia green building.

4. Progress in green developments

4.1. Pre-NGTP2009

Before the NGTP2009, energy developments in Malaysia focus mainly on achieving EE and generation of RE in energy sectors. The subject has been discussed in details in [11], and a summary is as shown in Table 3. Also, under the NBP2006, Malaysia has been recognised in the use of palm methyl esters and the blend of processed palm oil (5%) with petroleum diesel (95%) as alternative fuel for the transport and industrial sectors. Throughout the world, the use of methyl esters as diesel has already achieved widespread acceptance. For instance, rapeseed oil is already produced in Europe. The demand in the European Union is projected to increase from 3 mil tonnes in 2005 to 10 mil tonnes in 2010 [12]. Other countries embarking on biofuel programmes are US, Brazil, India, Japan, Korea and Thailand.

4.2. Post-NGTP2009

4.2.1. Green financing scheme

Green Technology Financing Scheme (GTFS) [13] was announced in National Budget 2010 and was the first given towards supporting GT and green buildings. It includes RM 1.5bil (USD 0.44bil) soft loan to companies and users of GT. The GoM will also subsidise 2% of the total interest rate as well as guaranteeing 60% of the financing amount via Credit Guarantee Corporation Malaysia (CGC) with the remaining 40% financing risk to be borne by participating financial institutions. It was reported that CGC has teamed up with CIMB Bank (the second largest financial service provider in Malaysia) for GTFS and that the latter will finance RM 150mil (USD 44mil) [14]. Financing up to RM 50mil for suppliers/producers and RM 10mil for users/consumers of GT can be obtained. More than 140 companies are expected to benefit from GTFS starting January 2010 and all applications are to be administered by GTM. As of April 2010, a total of 44 applications had been received with 19 being approved at an estimated financing of RM 518mil (USD 152mil) with carbon reduction estimated at about 1.12 mil tonnes [15] as shown in Table 4.

Commercial banks in Malaysia are also going into GT financing in view of the potential market for environmental business. Of the foreign commercial banks in Malaysia, Sumitomo Mitsui Banking Corp. of Japan has teamed up with the Federation of Malaysian Manufacturers (FMM) to provide RM 632mil (USD 200mil) financing for local manufacturers. It is the first kind of financing from a commercial bank to be used on green initiatives such as RE, recycling

Table 4
GTFS applications from producer and users of GT.

Sector	Accepted and processing	Evaluated by GTFS technical committee		
		Approved	Rejected	Total
Energy	28	12	3	15
Building	1			
Water and waste management	13	7		7
Transportation	2		1	1
Total	44	19	4	23
Financing (RM 'mil)	1444	518	161	679

Table 5
Green financing from various banking institutions.

Bank	Descriptions
Sumitomo Mitsui	USD 200mil financing for local manufacturers on green initiatives such as RE, recycling and waste management projects
HSBC	Offer special green financing rates to encourage customers to conduct their business in a sustainable manner. It has launched a Commercial Banking Green Campaign since November 2009
Maybank	Provide advice and financial assistance to companies intending to upgrade their manufacturing process, green their premises or go into large-scale implementation of clean development mechanism and green projects such as waste water treatment plants, solid waste recycling plant, oil palm biomass steam powered generator and construction of green buildings
Standard Chartered	Green financing is opened to all sectors, including biomass and biofuels

and waste management projects. A Memorandum of Understanding (MoU) on developing environmental business with FMM and Green Purchasing Network Malaysia (GPNM) has also been signed on 20 April 2010 [16]. Other banks offering green financing include HSBC, Maybank and Standard Chartered as shown in Table 5 [17]. Recently, at the 6th World Islamic Economic Forum, The PM has also proposed the setting up of a Clean Energy Development Bank to boost eco-sustainable efforts by developing countries of the Organisation of the Islamic Conference [18].

4.2.2. *Green townships*

The GoM plans to initiate green townships in which Putrajaya (federal territory and administration centre of Malaysia) and Cyberjaya (the 'Silicon Valley' of Malaysia with state-of-the-art integrated multimedia, infrastructure, transportation and information technology system) are to be the pioneer showcase townships, to be developed by Putrajaya Holdings and Cyberview Sdn Bhd, respectively. Main goals are to introduce green township guidelines cooperative with Malaysia Institute of Planners (MIP) and a green rating system to promote environmental friendly living and take the lead in adopting green building standards. Other goals includes 10% saving in energy and water in all government buildings and setting a carbon footprint baseline using common carbon metric (CCM) developed by UN Environment Programme-Sustainable Building and Construction Initiatives (UNEP-SBCI) to calculate carbon emission or GHGs by the development of green township in Putrajaya and Cyberjaya.

4.2.3. *Green procurement and eco-labelling*

Green procurement is to be implemented in all government agencies. The mechanism is to be developed under MEGTW and Ministry of Finance. This includes also working with SIRIM (Malaysia's research and standards development organisation) to develop green procurement manual, procedures and standards, certification and labelling mechanism to ease management between government and private sector in green purchasing. Through SIRIM, the government is also embarking on developing eco-labelling for local products which will be internationally recognised in support of green procurement. There is also a need to promote greater labelling of environmentally friendly goods and services for easier identification by consumers such as EE Star Rating, organic food and Green Building Index as it will be critical in securing buy-in from the public in supporting the green economy [19].

4.2.4. *Green vehicles*

The Ministry of Transport and Ministry of International Trade and Industry (MITI) together with MEGTW have been working towards developing infrastructure roadmap for the using of electric vehicles in Malaysia. This green initiative for the transportation sector is pursued via the National Automotive Policy (NAP). NAP was introduced in 2006 to highlight the development of related infrastructure to promote hybrid and electric vehicles as described in Table 6 [20]. In October 2009, NAP was reviewed with the vision of making Malaysia a regional automotive hub for green cars and technologies as well as attracting more local and international companies to manufacture and assemble green cars. MEGTW has been tasked with the development of Electric Vehicles Infrastructure Roadmap and GTM to work on the development of the roadmap. Recently, a series of concept global range-extended electric cars have been unveiled by Malaysian car manufacturer, Proton at the Geneva Motor Show [21]. The prospect of dedicated biodiesel engine vehicles to be used in Malaysia has also been reported in [22]. In year 2011, the sale of biofuel in Malaysia will be mandatory. This implementation is part of the GoM's biofuel initiative (under B5 programme), with biofuel derived from blending 5% palm methyl ester and 95% petroleum diesel [23].

4.2.5. *Green jobs creation*

Green topics are included into skill training within government agencies especially for Ministry of Human Resources, Ministry of Youth and Sports, Ministry of Tourism and Ministry of Rural and National Development with the aim to generate sufficient pool of green skilled workers. Through the introduction of NGTP2009, tremendous growth prospects of new projects and spin-off projects with the availability of the GTFS, which in turn is expected to create around 600 green collar jobs within the next three years [24]. Among the green jobs include RE and environmental consultants, project managers, green building architects, designers and engineers, green vehicle engineers, green business owners, green auditors, environmental educators, green technologists, construction workers in green developments, etc.

4.2.6. *Green awareness*

According to Minister of MEGTW during the launched of GTM, green awareness was launched to foster green minds, to encourage a green cultured society and to inculcate green practices in young Malaysians. Green courses are to be included into the national education syllabus through Ministry of Education and Ministry of Higher Education including both public and private institutions. A

Table 6
Types of green vehicles.

Green vehicle	Descriptions
Hybrids	*Conventional*: combine two or more different propulsion systems, typically a gasoline engine and one or more electric drive motors. Engines running on diesel or other alternative fuels can also be used *Plug-in*: plug-in hybrids boast great potential for improving fuel economy. Plug-in hybrid technology allows gasoline electric hybrid vehicles to be recharged from the grid. A gas engine provides additional driving range as needed after the battery power is gone
Electric cars	Electric cars produce zero localised emissions. Propelled by electric motors that run on batteries charged at home, or special electric vehicle charging stations. Electric cars are extremely efficient, much cheaper than any other alternative fuel

programme on GT applications and practices for 13 primary and lower secondary schools called Amalan Sekolah Rintis has been introduced. This is followed by the launched of Greentition Awards Programme which aims at raising awareness and encouragement in GT practices and embracing green lifestyles among the general public, schools, universities and members of the media. For instance, the Schneider Electric's University Challenge is one of the award programme designed to inspire engineering students at government and private universities in Malaysia to develop creative and innovative proposals at solving practical energy usage problems. It also educates future engineers to be more aware of energy efficient solutions and sustainable practices that can help protect and preserve the planet. The theme for 2010, Green the World @ My Campus tasks students with finding energy efficient solutions that can be implemented in their campus. The team from University Malaya (UM) was the winner of the Schneider Electric's University Challenge for its intelligent lighting and centralised air conditioning system, followed by the team from Universiti Tunku Abdul Rahman (UTAR) and another team from UM. The winning team received bursary of RM15k (USD 4.4k), trophies and certificates of honour. The runner-up and second runner-up receive RM10k (USD 2.9k) and RM5k (USD 1.5k), respectively [25].

4.2.7. Green conferences

National and international conferences have also been organised towards discussing updates, trends, policy and framework, business opportunity and financing, emerging GT, certification processes, RE and EE, and many areas related to GT as well as to promote Malaysia as the regional hub for GT. For instances: (i) the National Forum on Green Technology and Innovation was held from 23 to 24 November 2009, (ii) the Malaysia Green Forum (MGF) was held from 26 to 27 April 2010, (iii) the National Conference on Green Procurement in the Public Sector was held on 21 May 2010, (iv) Green Technology Seminar was held on 17 June 2010, (v) the International Green Technology and Eco Products Exhibition and Conference in Malaysia (IGEM 2010) to be held from 14 to 17 October 2010, and (vi) the Asia Pacific Regional Conference and Exhibition on Energy Efficiency (APACEEE 2010) to be held from 18 to 21 October 2010.

5. Green buildings

A green building focuses on increasing the efficiency of resource use such as energy, water, and materials while reducing building impact on human health and the environment during the building's lifecycle, through better sitting, design, construction, operation, maintenance, and removal [26].

5.1. Energy efficiency

Back in the early 2000, the GoM had set out to create awareness about green or low energy building. The GoM had directed all government offices to reduce energy consumption by 10%. The standard building energy index (BEI) was recommended to be no more than 135 kWh/m^2/year. In 2001, Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-residential Buildings, Malaysian Standard (MS) 1525:2001 was introduced. This was later revised to MS1525:2007 to encourage the application of RE in new and existing buildings to minimise non-renewable energy sources, pollution and energy consumption while maintaining comfort, health and safety of the occupants. Minimum building standards must fall within [27]: (i) architectural and passive design which include sustainable approach, passive strategy, site planning and orientation, daylighting, façade design, natural ventilation, strategic landscaping and the use of RE, (ii) building envelope, (iii) lighting, (iv) electrical power and distribution, (v) air conditioning and mechanical ventilation system, and (vi) energy management control system.

The Low Energy Office (LEO) of MEGTW, Zero Energy Office (ZEO) of GTM and Diamond Building of the Energy Commission (EC) of Malaysia are examples of implementing EE in buildings. LEO was first planned to have energy savings of more than 50% for EE of the building with an extra construction cost of less than 10%, giving a payback period for the extra investment of less than 10 years. To date, LEO has achieved its BEI close to 100 kWh/m^2/year (more than 50% compared to conventional building with average 250 kWh/m^2/year). In an energy audit on 68 office buildings in 2006 conducted by MEC, it was found that air conditionings, lightings, lifts and pumps and other equipment consume 57%, 19%, 18% and 6% of the electricity consumption, respectively [28]. As observed, air conditioning and lighting were identified as major energy using equipment in office buildings. It was also reported that the LEO building showed a reduction in energy consumption of 62%, 18% and 20% in air conditioning, lighting and other equipment. On the other hand, ZEO requires that the building must not consume more electricity than can be produced using RE sources on site. It was designed to be a key demonstration building for EE in Malaysia with a BEI of 65 kWh/m^2/year compared to typical conventional office building. ZEO has since be renamed to GEO (green energy office) with BEI 35 kWh/m^2/year, achieved through the used of building integrated photovoltaic (BIPV) panels. The BIPV system was also connected to the national grid to feed excess energy generated during the daytime. Diamond Building of EC has a BEI of 85 kWh/m^2/year and was designed and built with the concept of a sustainable building with consideration of: (i) reduction in fossil fuels, (ii) water conservation, (iii) sustainable building materials, (iv) waste minimisation and avoidance, (v) indoor environmental quality, (vi) traffic and transport management, and (vii) construction and demolition management plan. From [29] and as shown in Fig. 2, normal office buildings produce about 150–200 kg/m^2/year of CO_2 while the LEO and GEO produce about 65 and 23 kg/m^2/year, respectively. CO_2 production of the Diamond Building has yet to be calculated, by our estimation it should be about 55 kg/m^2/year. To commemorate the success of energy efficient implementation in buildings, the energy efficient building stamps have been issued in 2009 as shown in Fig. 3.

Under the Tenth Malaysian Plan, all new government buildings will be designed to meet green standards. EE of existing buildings will be enhanced and as a showcase example, the PM's Office complex will be upgraded to meet the Gold Standard Green rating [30]. The GoM will also stop all production, import and sales of the incandescent light bulbs by January 2014 as part of efforts to save power. The move would help reduce CO_2 emissions by 732 ktonnes a year and the shift to more energy efficient bulbs will help reduce energy usage by 1074 GW a year or RM 336mil (USD 99mil) a year in energy costs, equivalent to 1% of the total energy usage [31].

5.2. Green building index

Buildings are expected to consume as much electricity as industrial and transport sectors combined in a developing country like Malaysia. In April 2009, Malaysian Institute of Architects (PAM) and the Association of Consulting Engineers Malaysia (ACEM) supported by MGBC, together with the building industry launched the Green Building Index (GBI) [26] to enable green grading and certification of Malaysian buildings. GBI is a rating system providing comprehensive framework for building assessment, which is similar to BREEAM in UK, LEED in USA, Green Star in Australia and Green Mark in Singapore as depicted in Table 7. With detailed comparative assessments and surveys from among the world's green building rating systems as in Table 8, Malaysia's GBI focuses on EE, indoor environment quality (IEQ), sustainable site planning and manage-

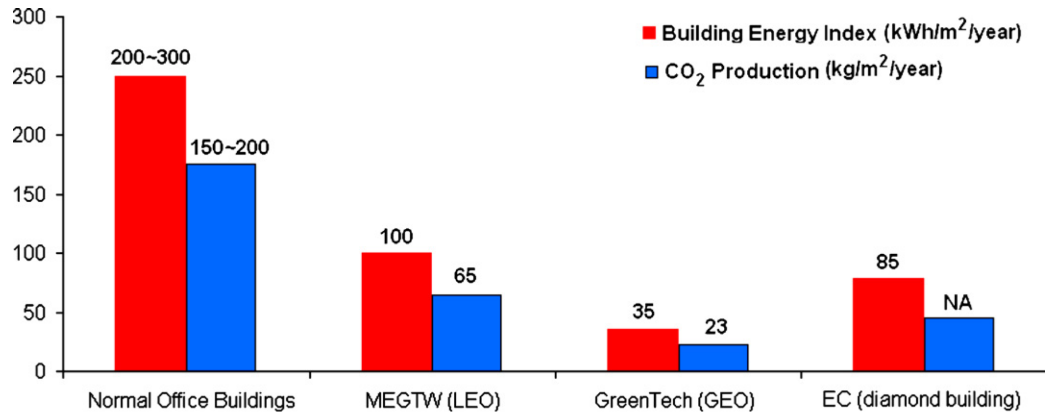


Fig. 2. Building energy index and CO_2 production.



Fig. 3. Energy efficient building stamps.

Table 7
Green building rating systems.

Country (Year)	Name
UK (1990)	Building Research Establishment Environmental Assessment Method (BREEAM)
USA (1998)	Leadership in Energy and Environment Design (LEED)
Australia (2003)	Green Star
Singapore (2005)	Green Mark
Malaysia (2009)	Green Building Index

ment (SSPM), materials and resources (MR), water efficiency (WE), and innovation.

GBI is developed specifically for the Malaysian tropical climate, environmental and developmental context, cultural and social needs and is created: (i) to define green buildings by establishing a common language and standard of measurement, (ii) to promote integrated whole building designs that provides a better environment, (iii) to recognise and reward environmental leadership, (iv) to transform the built environment to reduce its negative environmental impact, and (v) to ensure new buildings remain relevant in

Table 8
Green building criteria.

Tools	Criteria
BREEAM	Management, health and wellbeing, energy, transport, water, materials, waste, land use and ecology
LEED	Sustainable site, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation and design/construction process
Green Star	Management, transport, land use and ecology, emissions, energy, materials, indoor environmental quality, and innovation
Green Mark	Energy efficiency, water efficiency, environmental protection, indoor environment quality, other green features and innovation
GBI	Energy efficiency, indoor environment quality, sustainable site and management, materials and resources, water efficiency, and innovation

Table 9
GBI criteria.

Criteria	Description
EE	Optimising energy consumption through building design such as orientation, heat, daylighting, using RE and adopting best practices
IEQ	Achieve good quality performance in indoor air quality, acoustics, visual and thermal comfort using low volatile organic compound materials
SSPM	Selecting appropriate sites with access to public transportation, community services, open spaces and landscaping while avoiding and conserving environmentally sensitive areas
MR	Use environmentally friendly materials from sustainable sources. Proper waste management construction and storage and recycling
WE	Utilisation of water through recycling, harvesting of rainwater and water saving fittings
Innovation	Other innovation design and initiatives that meet the GBI objectives

the future and existing buildings are refurbished and upgraded to improve the overall quality of building stock. It is the first and only non-governmental and profession driven green rating tool developed for the tropical climate. A score of 50–65 in the GBI is required to achieve certification and the GBI criteria are as shown in Table 9 while Table 10 depicts the scores allocated for each criterion. Scores of 66–75, 76–85, and above 85 will be rated as Silver, Gold, and Platinum, respectively. The awarded GBI rating will only be valid for three years and buildings will have to be reassessed in order to maintain their GBI rating. The GEO of GTM is the first GBI certified building (on July 2009) as well as the first completed green rated office building in Malaysia [26].

There are currently two GBI tools in Malaysia—GBI for residential and GBI for non-residential buildings. The non-residential GBI evaluates commercial, institutional and industrial buildings such as offices, hospitals, universities, hotels and shopping complexes. The rating emphasises more on EE and IEQ. On the other hand, residential GBI evaluates residential such as houses, apartments, condominiums, and bungalows emphasising on SSPM followed by EE to encourage developers and building owners to consider the environmental quality of homes. Other rating tools in the pipeline are: (i) township tool, and (ii) industrial/factory tool.

MS1525 Code of Practice on Energy Efficiency has yet to be fully adopted and incorporated into buildings at the design stage although standard BEI is recommended to be no more than 135 kWh/m^2/year. The Housing and Local Government Ministry is said to be reviewing the Uniform Building By-Laws (in existence since 1995) in promoting the use of green technologies in buildings to create a more sustainable living environment for homeowners [32].

5.3. Others

The Green Solutions Property Development Conference held in 17 May 2010 in Kuala Lumpur, Malaysia is the first carbon neutral real property development conference organised by Real Estate and Housing Developers' Association (REHDA) Institute, Eastern Regional Organisation for Planning and Human Settlement (EAROPH) Malaysia Chapter and Sime Darby Property Bhd. It brought together developers, government and industry professionals such as architects, project managers, GT inventors, etc. to share their views and discuss on Malaysia's green movements, sustainable technologies and practices in green building design including reducing building costs, generate higher return and providing sustainable built environment as well as healthy living. Among the topics discuss included the role of Malaysian developers, low energy/carbon-neutral sustainable design for the built environment, Malaysia's GBI, incentives and tax exemptions for GT and a roundtable on the outlook of green solutions for property development.

Table 10
GBI grading systems.

Criteria	Residential	Non-residential	
		New	Existing
EE	23	35	38
IEQ	11	21	21
SSPM	39	18	10
MR	9	11	9
WE	12	10	12
Innovation	6	7	10

6. Green benefits and incentives

EE measures, utilisation of RE, encouraging the use of GT in energy, buildings, water and waste management, and transport sectors have helped in unnecessary waste of energy as well as cost and prevents environment degradation. As reported in [33], the green benefits include: (i) monetary—an estimated savings of RM 1bil (USD 0.3bil) in energy related costs for users and additional savings and RM 5bil (USD 1.5bil) related to investments in utility infrastructure, (ii) save depleting non-renewable fuels—using energy efficiently saves overall fuel consumption and extends the lifetime of scarce reserves, all of which add up to energy cost savings for users. It was reported in [34] that Malaysians are among highest fuel consumers in Asia region, at more than 400 l per capita annually in 2007. Hence, by going green, fuel consumption can be saved and energy production using fossil fuels can be extended, (iii) preserving the environment—going green by adopting RE and EE reduces GHG emissions and helps to protect the environment, and (iv) improve foreign reserves—according to the Oil and Gas Journal (OGJ), Malaysia held proven oil reserves of 4 bil barrels and 83 tri ft^3 of proven natural gas reserves as of January 2009. Total oil production in 2008 was 727,000 barrels/day and natural gas reaching 2300 bil ft^3 in 2007 [35] as shown in Figs. 4 and 5, respectively. The GoM estimated that at the current production rates, Malaysia would only be able to produce oil for the next 18 years and gas for next 35 years and become net importer of fuels. Although oil prices are assumed to fall from 2008 level of USD 97 per barrel to USD 60 per barrel in 2009, it is predicted to rebound to USD 100 per barrel by 2020 and USD 115 per barrel by 2030 [1]. Hence, energy savings translates to less cost being spent on imported fuels and

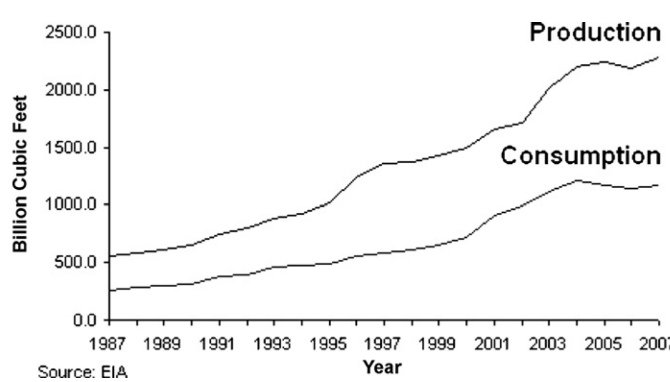


Fig. 4. Natural gas production and consumption in Malaysia, 1987–2007.

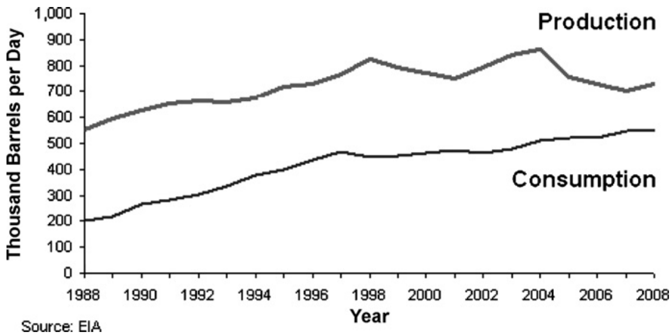


Fig. 5. Oil production and consumption in Malaysia, 1988–2008.

less cash flow out of the country, thus leaving more to explore local resources that earn, not deplete, foreign exchange.

Fiscal incentives was first provided in National Budget 2001 and subsequently upgraded in National Budget 2009. This includes: (i) Pioneer Status: provides exemption from income tax (25%) on 100% of statutory income for 10 years. Accumulated losses and unabsorbed capital allowances incurred during the pioneer period can be carried forward and deducted against post pioneer income of the company, (ii) Investment Tax Allowance: 100% of qualifying capital expenditure incurred within a period of 5 years can be utilised against 100% of the statutory income for each year of assessment. Unutilised allowances can be carried forward to subsequent years until fully utilised, and (iii) Exemption from payment of Import Duty and/or Sales Tax: Companies generating RE can also apply for ID-STE on imported machinery, equipment, materials, spare parts and consumables used directly in the generation process and that are not produced locally. For locally purchased machinery, equipment, materials, spare parts and consumables, full exemption is given on sales tax. The incentives are valid for any EE projects related to generation of RE and energy conservation. All applications are effective within August 2008 to December 2010. More detail information may be obtained from [36]. In the recently announced National Budget 2011, these tax incentives have been extended by another 5 years.

In addition to EE projects, separate incentives to encourage GT in buildings are announced in National Budget 2010. They are: (i) owners of GBI awarded buildings will be given tax exemption equivalent to 100% of the additional capital expenditure incurred to obtain the certificate, which can be set-off against 100% of statutory income for each year of assessment. It is applicable for new buildings as well as upgrades of existing ones, and (ii) buyers of buildings and residential properties of GBI awarded buildings bought from real property developers are eligible for stamp duty exemption on instruments on transfer of ownership of such buildings. The amount of stamp duty exemption is on the additional cost incurred to obtain the GBI certificate. This incentive is only given once to the first owner of the building. All sales and purchases for the incentives to be effective from October 2009 until December 2014.

On green vehicles, National Budget 2009 announced a 100% exemption of import duty and 50% exemption in excise on new completely built-up units of hybrid cars valid from August 2008 to December 2010. This is further extended by another year in National Budget 2011, inline with vision of making Malaysia a regional automotive hub for green cars and technologies.

7. The way forward: green future

In the early 2000s when RE and EE programmes (such as MIEEIP and SREPP) were first introduced, it had been constantly plagued with impeded growth due to: (i) restricted access to financial resources, (ii) lack of regulatory framework, (iii) lack of awareness, (iv) high cost of RE equipments, and (v) availability of non-renewable resources. After a decade of implementing RE and EE development programmes as well as continual environmental degradation coupled with the government's call for green and sustainable development, the public and private sectors have beginning to show willingness in generating RE and implementing EE programmes. Financial resources and grants are now widely available and the cost of RE equipment worldwide has also been decreasing and thus more affordable.

ASEAN countries including Malaysia are expected to play important role in global energy market for the decades ahead. The ASEAN primary energy demand is said to expand by 76% between 2007 and 2030 with annual growth rate of 2.5%, higher than the average rate in the rest of the world [1]. Malaysia's two closest neighbours, Thailand and Singapore are already implementing various green plans to ensure sustainable development. The Thai government has entered into a joint agreement with the World Bank called the Country Development Partnership for Environment (CDP-E) aiming to ensure the need for more stringent measures to uphold environmental standards. The partnership focuses on a fourfold approach on: (i) air control, (ii) water quality, (iii) waste, toxic and chemical control, and (iv) institutional support. The World Bank has also supported studies leading to the creation of the Ministry of Natural Resources and Environment in Thailand and future plans have been set focusing on environmental regulation, compliance and finance. Recently, a Clean Technology Fund Investment Plan between the Thai government, the World Bank, the Asian Development Bank, the International Finance Corporation, and other development partners has been introduced to develop low-carbon technologies particularly in the transportation and energy sectors [37]. On the other hand, Singapore launched its Green Plan 2012 (SGP2012) since 2002 [38] which highlighted environmental sustainability and targets until 2012. There were six focus areas in SGP2012: (i) clean air and climate change, (ii) water supply, (iii) waste management, (iv) public health, (v) conservation of nature, and (vi) international environmental relations.

The Ministry of Natural Resources and Environment (NRE) in Malaysia coordinates environmental issues and natural resource management. National Physical Plan (NPP) 2005–2010 was implemented to enhance integrated land use planning, improve standards and indicators for land planning and natural resource management. On the other hand, National Biodiversity–Biotechnology Council (NBBC) was established to coordinate efforts for the conservation and sustainable utilisation of biological resources. Malaysia's two most notable international involvements are the Montreal Protocol and the Kyoto Protocol. Malaysia ratified Vienna Convention and Montreal Protocol on 29 August 1989. Subsequently the Public Services Department, Malaysia set up an Ozone Protection Section (OPS) under Department of Environment in January 1997. OPS served as the national focal point and one-stop agency for coordinating, monitoring, and implementing all of the Montreal Protocol Ozone-Depleting Substances (ODS) phase-out activities. The government formulated policies and strategies to restrict and limit the use of ODS as well as promoted the use of non-ODS substitutes and alternatives. Under the GTFS announced by the government, RE generation projects under SREP programme and clean development mechanism (CDM) are qualified for the scheme in which the latter is seen with huge potential. Malaysia ratified the Kyoto Protocol on 4 September 2002 as a non-Annex I Party. Malaysia is allowed to engage in CDM projects with any Annex I Party for reduction of GHG emissions while gaining carbon credits through certified emission reductions (CER). From the Malaysia Initial National Communication report submitted to United Nations Framework Convention on Climate Change (UNFCC) by Ministry of Science, Technology and the Environment on July 2000 [39], Malaysia's GHG emissions totalled to 144 mil tonnes of CO_2 equiva-

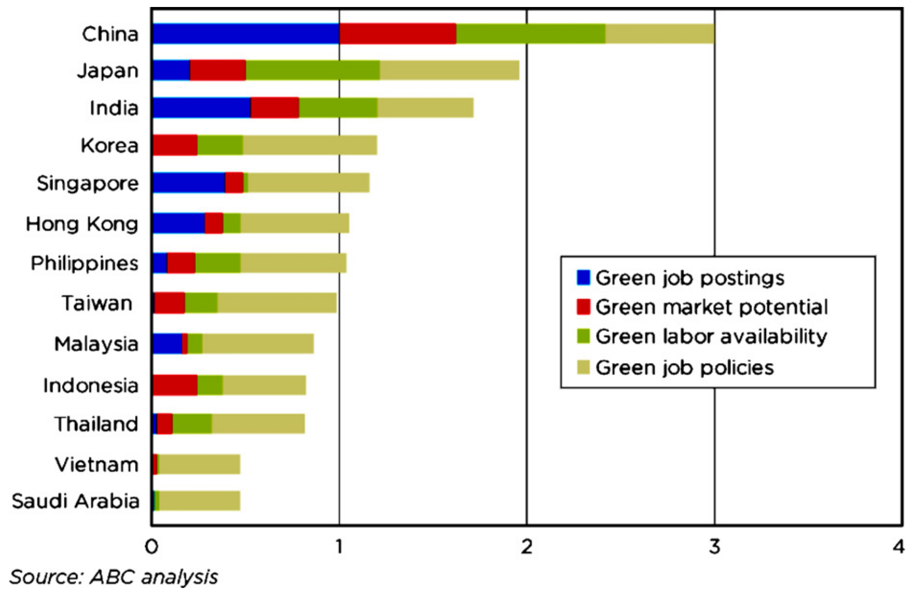


Fig. 6. Asia green jobs index by ABC.

lent in 1994. The net emissions after accounting for sinks totalled to 76 mil tonnes of CO_2 equivalent. CO_2 accounted for 67.5%, methane 32.4% and nitrous oxide 0.1% of the total CO_2 equivalent emissions. Of these, fuel combustion from energy sector contributed the most with 86.7% of total CO_2 emissions. Malaysia has a huge potential in terms of carbon trading by involving in the CDM projects. It was reported in [40] that the annual potential in Malaysia reached 18 mil CERs in 2010, about 100 mil tonnes of CO_2 equivalent between 2006 and 2012. MEC estimated that with the price range of USD 3–10 tonnes of CO_2 equivalent, it would represent a cash flow of USD 0.3-1 bil to Malaysia from carbon trading. In 2007, Malaysia was the first country in the world to be awarded CERs by the UN Executive Board of CDM via a biomass project. To further strengthen Malaysia's subscription to combating climate change and conserving the environment under Kyoto Protocol, the PM had announced to voluntarily slash by up to 40% of CO_2 emissions by 2020 compared with 2005 levels [41]. Further information on Malaysia's carbon trading potential can be found in [42].

Another international collaboration is the UN Development Programme (UNDP). UNDP supports initiatives that contribute towards ensuring sustainability in core strategies which includes: (i) the enhancement of environmental management of biodiversity and natural resources, (ii) mitigating GHG emissions through the implementation of RE and EE projects, (iii) reducing ODS consumption, (iv) the incorporation of environmental considerations into the planning and development of non-environmental agencies., and (v) providing innovative policy advice on climate change and works with relevant government ministries and their agencies [43]. MIEEIP, BioGen and MBIPV are the EE and RE initiatives assisted and supported under UNDP, co-funded by Global Environment Facility (GEF), the Government of Malaysia and private sector.

On the green employment side, according to a UN report, development of alternative energy should create more than 20 mil employments around the world in coming decades as governments adopt policies to reduce GHG emissions [44]. In a recent Asia Business Council (ABC) report on Addressing Asia's New Green Jobs Challenge which measures green jobs index in terms of green job postings, green market potential, green labour availability and green job policies in 13 selected Asia economies showed that China has the most favourable conditions for overall green jobs creation, leading in green job postings and green market potential. This is followed by Japan and India. In ASEAN, Singapore topped the green jobs index, followed by Philippines and Malaysia as shown in Fig. 6 [45].

According to the World Green Building Council, buildings are actually the single largest contributor to global warming accounting for one-third of global CO_2 emissions. In Malaysia, commercial and residential buildings use about 13% of total energy consumption and 48% of electricity consumption [33]. Malaysia's GBI is a voluntary rating tool and the registration fee is also relatively lower compared to other green ratings. Singapore has been one of the leading countries in Asia to continuously upgrade its building codes and implement good building practices. The Green Mark certification has been made mandatory in April 2008 for all new buildings or on existing building works exceeding 2000 m^2 [46,47]. The Australian government has also enacted mandatory disclosure of EE information for any commercial space of area 2000 m^2 or more to prospective buyers or tenants implemented in the second half of 2010 [48].

Although the GoM provides green incentives as well as creates sufficient awareness, the implementation of EE regulations in buildings remains doubtful due to lack of mandatory legislations. The tax incentives are said to be insufficient in encouraging the developers and other industry players [49]. Resistance to change and to new technology, plus relatively cheap electricity tariffs, have further stumped the growth of green architecture [50]. The one most difficult obstacle for building developers is the cost related to construction of the green features. This can cost as much as 30–40% more, depending on the greening process [51]. There have been suggestions to give enhanced tax incentives. For instance, the cost for an entire green building rated as Platinum or Gold could qualify for tax write-off instead of the additional costs to obtain the GBI certificate and double deduction could be given on costs incurred on renewal of GBI certificate. The energy efficient assets incurred by the Platinum or Gold green building owners might also qualify for tax incentive. The tax incentives could also be extended to property developers when they develop green townships [52]. It was reported in [53] to further encourage EE implementation in industrial and building sectors, Malaysia could implement Buildings and Industrial Energy Efficiency award system. For transportation sector, there was also a proposal to introduce attractive indirect tax incentives for the purchase of hybrid cars [52]. It was reported that EE investments in buildings, industry and transport have short pay-

back periods as fuel cost savings over the lifetime of the capital stock often outweigh the additional capital cost of the efficiency measure [1].

The responsibility in ensuring green environment and sustainable development require environmental awareness and cooperative from all parties such as government, public and private sectors and as well the end-users. Apart from government's roles in establishing green roadmaps and enacting policies, the electricity utilities and the customers remain the two most important parties in supporting green development. Utility customers interested in supporting the use of RE to generate electricity can opt to pay a premium on top of their normal electricity bill to help fund RE systems owned by the utility, called the green pricing mechanism (GPM). This requires a high degree of awareness and environmental consciousness among the population. However, the contribution to market development is hard to predict. The GPM will therefore be most effective as a follow up to other schemes such as investment grants and feed-in tariffs. Since the electricity prices are relatively low in Malaysia, which makes the difference between the conventional electricity price and the green power price very big, this has made it difficult for consumers to participate in this scheme. Furthermore, since 2009, the GoM provides subsidy for residential consumers utilising electricity up to RM 20/month (USD 6/month). Even the industrial and commercial sectors had an average reduction of 5.0% and 2.7%, respectively compared to former tariff [54]. Hence, the willingness to pay depends on the incremental cost for green power and the environmental consciousness of the consumers.

Electricity supply service in Malaysia is integrated with three main electricity utilities: (i) Tenaga Nasional Bhd (TNB) in Peninsular Malaysia, (ii) Syarikat SESCO Bhd (SESCO) in Sarawak, and (iii) Sabah Electricity Sdn Bhd (SESB) in Sabah; for operating generation, transmission, distribution and supply activities. In addition, there are about 18 investor-owned independent power producers (IPPs) supplying power to these utilities. Several mini utilities generate electricity or purchase power from the main utilities for their own use with excess power supply sold to consumers within certain dedicated areas [33]. The electricity utilities may opt for Renewable Portfolio Standards (RPS) scheme. Under RPS, utility operators are obliged to supply a specified amount of electricity which must come from RE to the end-users where RE may be generated by the utility or buy from IPPs. This scheme is most suitable for commercially mature RE technologies such as hydro and biomass.

It is projected that Malaysia would have 11% (2000 MW) of the generation mix coming from RE sources by 2020. To make this possible, the government has approved a Renewable Energy Policy and Action Plan (REAP) which will be implemented by MEGTW in 2011 once the institutional framework for RE Law and implementing agency are put in place. This policy is expected to enhance RE utilisation and sustainable development in the energy sector through objectives: (i) increasing RE contribution in the national power generation mix, (ii) facilitating the growth of the RE industry, (iii) ensuring reasonable RE generation costs, (iv) conserving environment for future generation, and (iv) enhancing awareness on the role and importance of RE. One of the attraction in REAP is the feed-in tariff (FiT) mechanism to be administered by Sustainable Energy Development Authority (SEDA). FiTs are RE payments of electricity in kilowatt-hour. It promotes exportation of electricity as a form of investment. Electricity users will be able to generate renewable electricity through RE such as biomass, biogas, wind, solar, etc. and sell it back to the national power grid at a premium rate [55]. The FiT scheme has proven to be the most effective mechanism for the RE industry in making competitive clean energy compared to the conventional fossil energy. FiT mechanism has been adopted by many countries in the world such as US, Spain, Germany, Thailand, etc. For Germany alone, the adoption of FiT is said to have created 214,000 jobs and avoided 97 mil tonnes of CO_2 emissions in 2006 [56]. Malaysia's implementation of FiT is thus on the bright side. Further information on Malaysia's FiT outlook may be found in [57].

8. Conclusions

Malaysia's green plans such as the NGTP2009 and GBI tool have been discussed. Various green initiatives are also currently in the pipeline, supported by the government, public and private sectors. The vision of a green future is tremendously bright in Malaysia if all the parties cooperate and collaborate with all synergistic efforts to make the plan a success. The penetration of green awareness among the public and private sectors has been encouraging and constant due to government's involvement in spreading green developments and offering various incentives as well as enacting green policies. Industrial and commercial players as well as building developers have beginning to realise the long term benefits and paybacks by going green, not accounting for the various benefits it would bring to the environment and for a healthier living. It was reported that Malaysia's GT industry is estimated to be worth more than RM 100bil (USD 30 bil) [58] and the outlook is thus very bright in the energy, building, water and waste management, and transport sectors. During the MGF, the PM stated that the three biggest challenges with regards to environmental sustainability are EE, cost effective GT and environmental awareness. The New Economic Model (NEM) which was revealed in 2010 to chart Malaysia's future economic growth puts sustainability as one of the three goals and aspires to place Malaysia as a green hub. With the worldwide trend in energy generation using RE and implementation of EE for greener environment and more sustained development, the prospects of green economy is certain and if the world community continues in its quest to support a greener future, the current environmental degradation and energy crisis might just be temporal.

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